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Our ref.: P18260PC00
Christian Abel

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application serial no.: 10/824,492
Inventor: Petter Muren
For: Rotor and aircraft passively stable in hover
Group No.:
Examiner:
Attorney docket no.: 116184

PETITION TO MAKE SPECIAL FOR NEW APPLICATION UNDER MPEP §708.02 VIII

Sir:

1. The applicant hereby petitions to make this application, which has not received any examination by the examiner, special.

2. Claims – All claims in the application are directed to a single invention

3. Search – An International-type Search Report, and an International Search Report have been prepared by the Swedish Patent Office (copies of which are attached hereto), the searches were performed in classes: IPC7 B64C. In addition, the applicant has conducted a free text search in the USPTO database, the results of which (including copies of references) have been previously submitted in an Information Disclosure Statement (attached hereto). In addition to the copies previously submitted with the IDS, a copy of US 5639215, from the ISR, is enclosed herewith (and should be considered as a SUPPLEMENTAL INFORMATION DISCLOSURE.

4. The reference US6659395 is considered to represent the closest prior art.

5. Detailed discussion of the prior art

US patent 6659395 to Rehkemper is believed to represent the closest prior art. The other references cited disclose the general state of the art, are not particularly relevant with respect to the present invention. None of these references disclose a rotor system wherein the rotating plane of the rotor is tiltable with respect to a reference plane, and whereby at least part of the rotor has a fixed pitch angle with respect to the rotating plane, and at least another part of the rotor that has a fixed pitch with respect to the reference plane.

Regarding US 6659395,

This patent uses the word propeller or main propeller instead of rotor, also when it refers to helicopters. This reference discloses a helicopter utilizing different kinds of rings or safety arcs attached to the tip of the propeller blades. It relies on gyroscopic forces to change the pitch of the whole propeller to secure stability, much like ordinary 2-blade rotors with large stabilizer bars. The purpose of the safety arcs, apart from making the propeller safer is described to be: When the main propeller rotates, if the main propeller begins to pitch (tilt about the longitudinal axis of the blades), the safety arcs will begin to move of the horizontal plane. The weight of the safety arcs however, create a gyroscopic effect causing the main propeller to level out by pivoting the blades about a pivot pin with a pivot axis parallel to the blades. This ensures that the propeller remains in, or returns to, a horizontal level.

In this helicopter, the propeller blades extend outwards from the shaft in a horizontal plane without any coning, and the blades are free to pivot in a way that changes the pitch along the whole propeller without any twisting or bending of the blades. Thus, the helicopter from this reference does not contain a rotor system wherein the rotating plane of the rotor is tiltable with respect to a reference plane, and whereby at least part of the rotor has a fixed pitch angle with respect to the rotating plane, and at least another part of the rotor that has a fixed pitch with respect to the reference plane, as is the case from the invention in the present application.

Applicant therefore respectfully requests this application be granted Special Status.

Please charge the petition fee of $130, and any and all other necessary fees during the pendancy of this application to deposit account 501898.

Respectfully Submitted,
ONSAGERS AS

Christian D. Abel

Reg no. 43,455

Cust. No. 29078

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Christian D. Abel 43, 455

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 2004/000108

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B64C 27/473
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B64C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	US 2003132341 A1 (GLOMSTAD ET AL), 17 July 2003 (17.07.2003), page 2, [0022]-[0037]; fig 1A, 2C; claims 1-7	1-4,7-10
A	US 5639215 A (YAMAKAWA ET AL), 17 June 1997 (17.06.1997), column 2, line 13 - line 37, figure 4, claim 1	4,6,10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 Sept 2004	15 -09- 2004
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Igor Gazdik/EK Telephone No. +46 8 782 25 00

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INTERNATIONAL-TYPE SEARCH REPORT

Search request No.
NO 03/00014

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B64C 27/473
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B64C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20030132341 A1 (GLOMSTAD ET AL), 17 July 2003 (17.07.2003), page 1 [0013] - page 2 [0037]; fig 1, 2; claims 1-7	1-4,7-14,19

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☐ Further documents are listed in the continuation of Box C. ☒ Patent family members are listed in annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international-type search	Date of mailing of the international-type search report
16 January 2004	2004-02-06
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Igor Gazdik/EK Telephone No. +46 8 782 25 00

Form PCT/ISA/201 (second sheet) (January 2004)

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PTO/SB/08A (10-96)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	10/829,492
Filing Date	April 15, 2004
First Named Inventor	Petter Muren
Group Art Unit	
Examiner Name	
Attorney Docket Number	116184

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	U.S. Patent Document Number	Kind Code[2] (if known)	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		6653595		Rehkemper	12-9-2003	whole doc
		2003/0111595		"	6-19-2003	"
		5971320		Jermyn	10-26-1999	"
		5297759		Tilbor	3-29-1994	"
		6192765		Weinhart	2-6-2001	"
		2003/0132341		Glemstad	7-17-2003	"
		6460902		Norris	10-8-2002	"
		2455866		Kaman	12-7-1948	"
		3213944		Nichols	10-26-1965	"
		5082079		Lassman	1-21-1992	"

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Office[3]	Number[4]	Kind Code[5] (if known)	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		WO	03089950		Kehco LLC	5-15-2003	whole doc	

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] Unique citation designation number. [2] See attached Kinds of U.S. Patent Documents. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

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US005639215A

United States Patent [19]

Yamakawa et al.

[11] Patent Number: 5,639,215

[45] Date of Patent: Jun. 17, 1997

[54] **HELICOPTER ROTOR EQUIPPED WITH FLAPS**

[75] Inventors: Eiichi Yamakawa; Noboru Kobiki; Eiji Shima, all of Kakamigahara, Japan

[73] Assignee: Advanced Technology Institute of Commuter-Helicopter, Ltd., Gifu, Japan

[21] Appl. No.: 607,103

[22] Filed: Feb. 26, 1996

[30] Foreign Application Priority Data

Mar. 27, 1995 [JP] Japan 7-065415

[51] Int. Cl.[6] B64C 27/615

[52] U.S. Cl. 416/23; 244/212; 244/215

[58] Field of Search 416/23, 24; 244/215, 244/17.25, 210–211, 212, 217, 213–214

[56] References Cited

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2,497,465	2/1950	Mullin	416/24
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4,461,611	7/1984	Michel	416/24

FOREIGN PATENT DOCUMENTS

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759672	10/1956	United Kingdom .

OTHER PUBLICATIONS

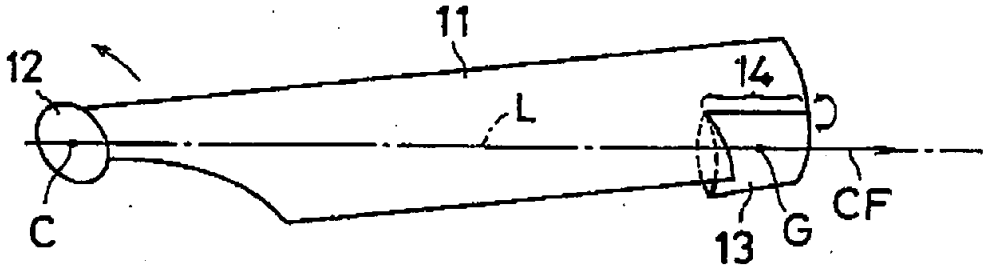
European Search Report, European Patent Office, Application No. EP 96 20 0549, Date of completion of the search: 1 Jul. 1996, 4 pages.

Primary Examiner—Christopher Verdier
Attorney, Agent, or Firm—Baker & Botts, L.L.P.

[57] ABSTRACT

A blade of the rotor is attached to a main rotor shaft, and is rotated counterclockwise at a high speed when viewed from above. In the vicinity of the blade tip, a flap having a wing shape in section is pivotally supported with a hinge so as to be angularly displaceable and at the end a part of the rear end of the blade is cut out. A hinge line which indicates the center of the angular displacement of the hinge is formed so as to be parallel to a straight line passing through the rotation center of the rotor and the center of gravity of the flap. A helicopter rotor equipped with flaps is provided in which the influence of the centrifugal force acting on the center of gravity of a blade can be largely reduced, and a flap control mechanism can be reduced in size and weight.

1 Claim, 4 Drawing Sheets



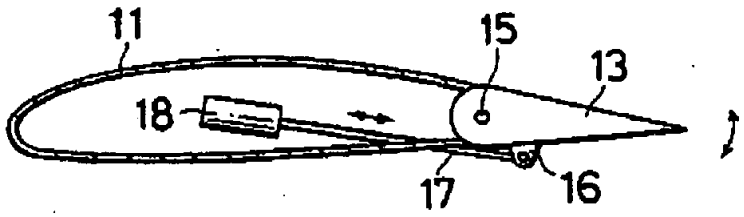


FIG. 1

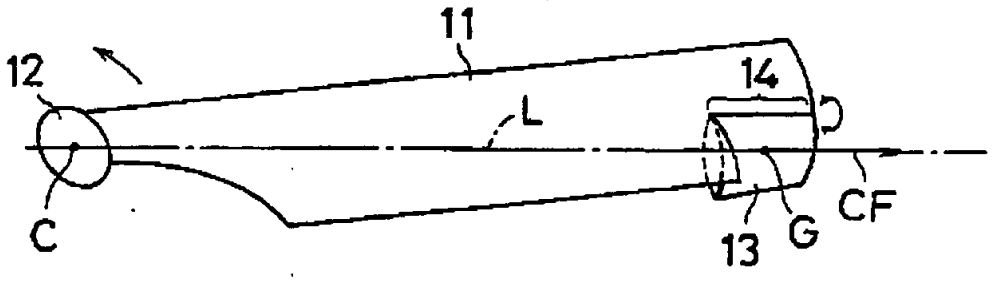


FIG. 2A

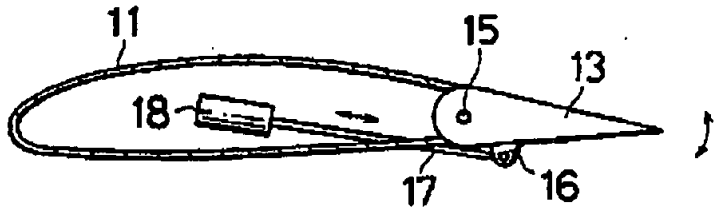


FIG. 2B

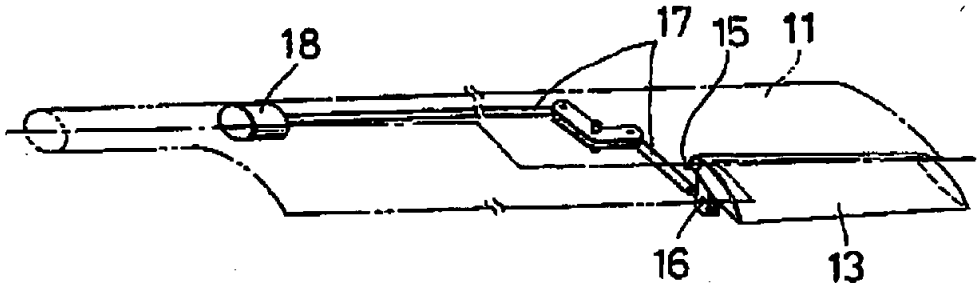


FIG. 2C

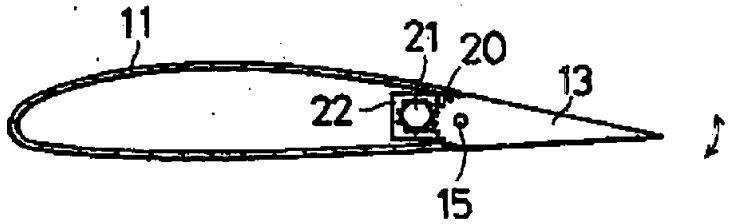


FIG. 3A

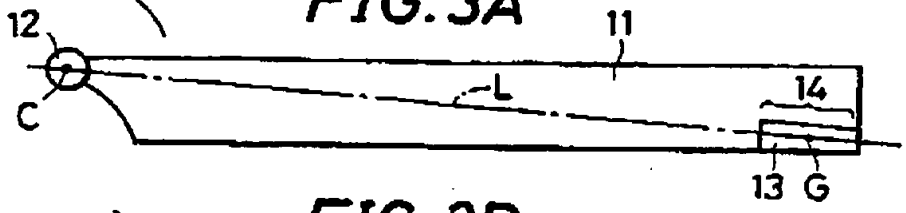


FIG. 3B

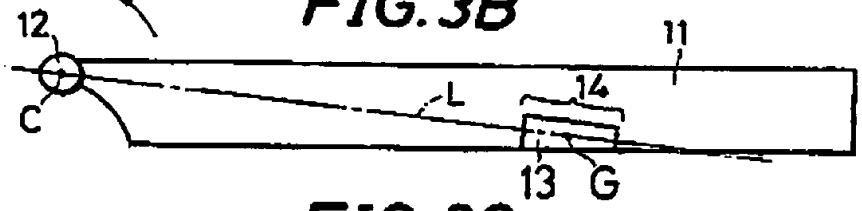


FIG. 3C

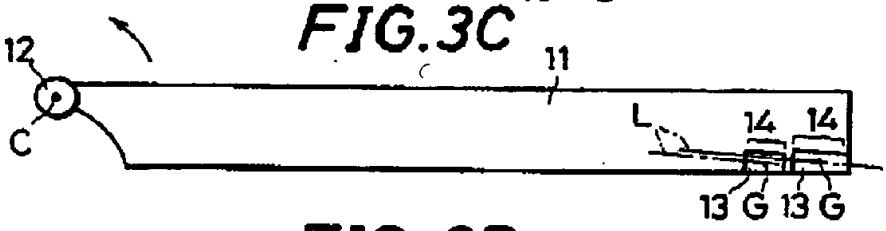


FIG. 3D

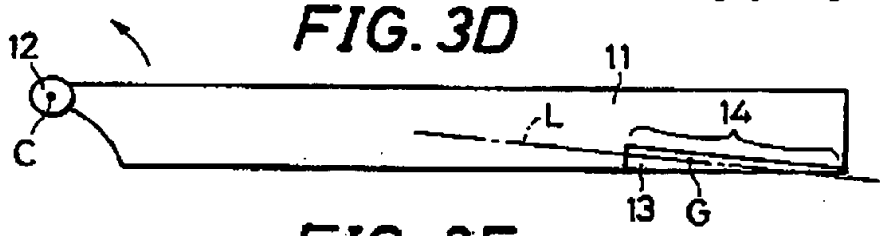


FIG. 3E

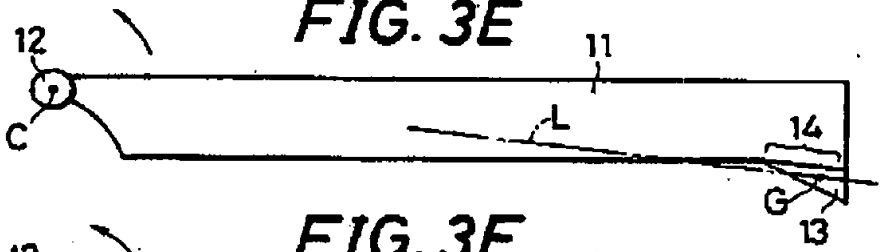


FIG. 3F

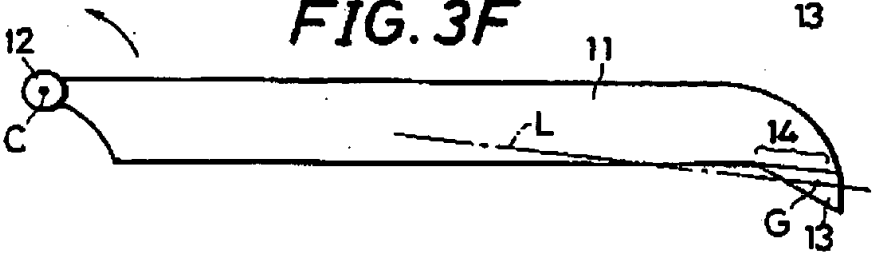
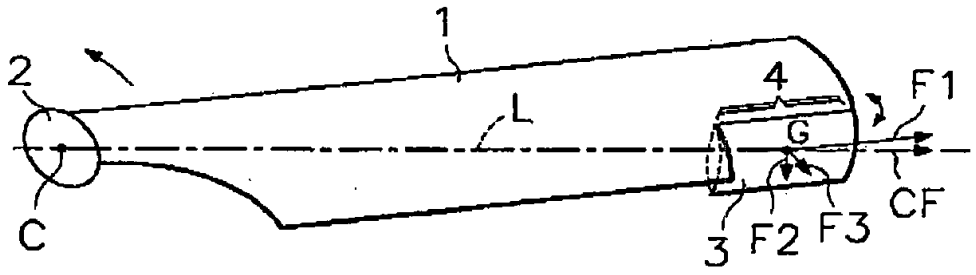


FIG. 4
(PRIOR ART)



HELICOPTER ROTOR EQUIPPED WITH FLAPS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a helicopter rotor equipped with flaps.

2. Description of the Related Art

A helicopter is generally maneuvered by controlling a pitch angle in a blade root of a main rotor by means of actuators, swash plates, link mechanisms, and the like.

The helicopter rotor is a high-speed rotatable element. Additionally the vibration level of the helicopter rotor is considerably high, so that a highly accurate mechanism is required for controlling the pitch angle of a blade. The aerodynamic moment generated about the feathering axis over the whole blade is large. In order to change the pitch angle of the blade against the mass of the rotor and control mechanism, a high-power actuator and a high-power hydraulic mechanism are required. Such requirements result in difficulty in reducing the weight of the structure of the helicopter.

As a countermeasure against such drawbacks, a method is proposed in which a relatively small flap is attached to the vicinity of a blade tip where a dynamic pressure is sufficiently high, and the pitch angle of a blade is controlled by utilizing a large aerodynamic force generated in that portion (for example, Japanese Unexamined Patent Publication JPA 6-107293 (1994) and U.S. Pat. Nos. 3,077,934, 3,129,769, 3,589,831, and 4,461,611). The attachment of a flap to the vicinity of a blade tip enables the pitch angle to be controlled with a small control force, so that the whole control mechanism can be reduced in weight as well as in size.

In a prior art helicopter rotor, a large centrifugal force due to the high-speed revolution of the rotor acts on the center of gravity of a flap. In the vicinity of the blade tip, for example, the centrifugal force has a large value which is about 1,000 times as large as the gravity.

FIG. 4 is a partial perspective view showing an example of a prior art of helicopter rotor. A blade 1 of the rotor is attached to a main rotor shaft 2, and rotated at a high speed in a counterclockwise direction when viewed from above. In the vicinity of a tip of the blade 1, a flap 3 having a wing shape in section is pivotally supported with a hinge (not shown) so as to be angularly displaceable and at the end a part of a rear end of the blade 1 is cut out. A hinge line 4 indicating the center of the angular displacement of the hinge is set in parallel to the spanwise direction of the blade 1, and crosses a straight line L passing through the rotation center C of the rotor and the center of gravity G of the flap, at about 2.5 degrees.

The centrifugal force CF acting on the center of gravity G of the flap is split into a component force F1 along the hinge line 4, a component force F2 along a wing chord direction of the flap 3 in a plane perpendicular to the hinge line 4, and a component force F3 along a wing thickness direction of the flap 3. The component forces F1 and F2 are supported by the hinge, but the component force F3 acts as a hinge moment about the hinge line 4 so as to angularly displace the flap 3.

In this way, a centrifugal force affects a hinge moment of the flap, and the following problems arise:

1) The moment due to the centrifugal force serves as additional load, so that the load conditions for the flap control mechanism become more severe, and it is difficult to design a compact mechanism.

2) Since it is necessary to increase the output power of a flap control actuator, it is difficult to design a compact actuator and a compact hydraulic system.

3) A component of the centrifugal force which is along a flap thickness direction causes torsion or flapping in the blade, so that there occurs an aeroelastic phenomenon which may cause an unexpected change in an effective angle of attack of a blade element, and the aeroelastic phenomenon adversely affects the flight performance, the flight characteristics, and the vibration level.

SUMMARY OF THE INVENTION

An object of the invention is to provide a helicopter rotor equipped with flaps in which the influence of a centrifugal force acting on the center of gravity of a flap is largely reduced, and the size and a flap control mechanism can be reduced in size and weight.

The invention provides an improved helicopter rotor equipped with flaps in which a hinge for pivotally supporting a flap in an angularly displaceable manner in relation to a blade is disposed, where the improvement comprises:

a hinge line formed in parallel to a straight line which passes through the rotation center of the rotor and the center of gravity of the flap.

According to the invention, the hinge line is formed so as to be parallel to a straight line passing through the rotation center of the rotor and the center of gravity of the flap. Therefore, the centrifugal force acting on the center of gravity of the flap acts in parallel to the hinge line, so that the hinge moment about the hinge line consists of only an aerodynamic moment, and the hinge moment is largely reduced. As a result, it is possible to realize compact designs of a flap control mechanism, a control actuator and a hydraulic system. In addition, since an additional load does not act on the flap, good flight characteristics of the helicopter are assured.

BRIEF DESCRIPTION OF THE DRAWINGS

Other and further objects, features, and advantages of the invention will be more explicit from the following detailed description taken with reference to the drawings wherein:

FIG. 1 is a partial perspective view showing an embodiment of the invention;

FIGS. 2A–2C show examples of a flap control mechanism;

FIGS. 3A–3F are partial plan views showing various examples of the shape of a flap; and

FIG. 4 is a partial perspective view showing an example of a prior art of helicopter rotor.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now referring to the drawings, preferred embodiments of the invention are described below.

FIG. 1 is a partial perspective view showing an embodiment of the invention. A blade 11 of the rotor is attached to a main rotor shaft 12, and rotated at a high speed in a counterclockwise direction when viewed from above. In the vicinity of a tip of the blade 11, a flap 13 having a wing shape in section is pivotally supported with a hinge (not shown) so as to be angularly displaceable and at the end a part of the rear end of the blade 11 is cut out. A hinge line 14 indicating the center of the angular displacement of the hinge is formed in parallel to a straight line L which passes through the rotation center C of the rotor and the center of gravity G of

the flap. For example, the hinge line 14 forms an angle of about 2.5 degrees with a straight line along the blade spanwise direction.

The centrifugal force CF acting on the center of gravity G of the flap acts in parallel to the hinge line 14, so that the hinge moment about the hinge line consists of only an aerodynamic moment. Accordingly, the hinge moment is largely reduced, which is about 1/5 times as much as that acting in the prior art rotor shown in FIG. 4. Therefore, the control mechanism for the flap 13, a control actuator, and a hydraulic system can be reduced in size and weight, and compact design can be realized, and additionally good flight characteristics of the helicopter are assured.

FIGS. 2A–2C show examples of the flap driving mechanism. In FIG. 2A, the flap 13 is pivotally attached to the blade 11 with a hinge 15, and another hinge 16 is attached to a lower face of the flap 13. The hinge 16 is coupled by a pin to a push-pull rod 17 which is driven by an actuator 18. Depending on the amount of linear displacement of the push-pull rod 17, the angle of the flap 13 is controlled.

FIG. 2B shows an example in which the position of the actuator 18 is moved to the inside portion of the blade where the centrifugal force is small.

On the other hand, in FIG. 2C, the flap 13 is pivotally attached to the blade 11 with a hinge 15. A rack 20 is formed in a portion of a circumferential face of the flap 13, and a pinion 21 which is engaged with the rack 20 is driven by a servo motor 22. Depending on the rotation amount of the servo motor 22, the angle of the flap 13 is controlled.

FIGS. 3A–3F are partial plan views showing various examples of the shape of the flap. In the example shown in FIG. 3A, in a similar way to that shown in FIG. 1, a flap 13 having a wing shape in section is pivotally supported in the vicinity of the tip of the blade 11 so as to be angularly displaceable and at the end a part of the rear end of the blade 11 is cut out. The hinge line 14 is set in parallel to the straight line L passing through the rotation center C of the rotor and the center of gravity G of the flap.

In FIG. 3B, a flap 13 is pivotally supported at a middle position between the blade tip and the blade root of the blade 11. The hinge line 14 is set in parallel to the straight line L passing through the rotation center C of the rotor and the center of gravity G of the flap.

In FIG. 3C, two flaps are pivotally supported in the vicinity of the blade tip of the blade 11 so that they are independently controlled. Each of the hinge lines 14 is set in parallel to the straight line L passing through the rotation center C of the rotor and the center of gravity G of the flap.

In FIG. 3D, a triangular flap 13 is pivotally supported in the vicinity of the blade tip of the blade 11. The hinge line 14 is set in parallel to the straight line L passing through the rotation center C of the rotor and the center of gravity G of the flap.

In FIG. 3E, a triangular flap 13 is pivotally supported in the vicinity of the blade tip of the blade 11 so as to be protruded from the rear end of the blade 11. The hinge line 14 is set in parallel to the straight line L passing through the rotation center C of the rotor and the center of gravity G of the flap.

In FIG. 3F, the blade is formed so that the end face in the vicinity of the blade tip has a smoothly curved shape, and a triangular flap 13 is pivotally supported so as to be protruded from the distal end of the blade. The hinge line 14 is set in parallel to the straight line L passing through the rotation center C of the rotor and the center of gravity G of the flap.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description and all changes which come within the meaning and the range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. In a helicopter rotor equipped with flaps in which a hinge for pivotally supporting each flap in an angularly displaceable manner in relation to a blade is disposed, the improvement comprising:

a hinge line formed in parallel to a straight line which passes through the rotation center of the rotor and the center of gravity of a respective flap.

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